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LEUCOGASTER AND LEUCOPHLEBS IN NORTH AMERICA

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LEUCOGASTER

Leucogaster Hesse, Jahrb. f. wiss. Bot. 13: 189-194. 1882; Bot. Centralbl. 40: 1-4, 33-36. 1889; Hypog. Deutschl. 1: 68-71. 1891; Saccardo, Syll. Fung. 9: 281. 1891, 14: 249. 1899, 17: 240. 1905; Fischer in Engler & Prantl, Nat. Pflanzenfam. I. 1^{**}: 311. 1899; Hollós, Magyarország Földalatti Gombai, 97-99. 1911.—*Leucophleps* Harkness, Cal. Acad. Sci. Proc. Bot. III. 1: 257-259. 1899 (in part).

The type species of the genus is *Leucogaster liosporus* Hesse.

Fructifications globose to irregular, hypogaeous to emergent, fleshy or waxy; fibrils sometimes present, leading to rhizomorphs; columella, stipe, and sterile base absent; peridium usually thin and fragile, sometimes rupturing at maturity; cavities frequently polyhedral, usually filled with spores embedded in a gelatinous mass; septa homogeneous, with or without a distinct trama, often gelatinizing at maturity; basidia from subglobose to ovoid and subcylindric, mostly 4-spored, sometimes 3- or 5-spored; spores hyaline or slightly colored, with various surface markings embedded in a gelatinous spherical mass.

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Leucogaster was placed by its author next to *Melanogaster* Corda, because the basidia are in less definitely organized layers than in the other genera of the *Hymenogastraceae*, while Fischer, considering its inseparable peridium and spore characters, placed it between *Hydnangium* Wallroth and *Rhizopogon* Fries. In several species the basidia are long-pedicellate, a fact which, in the absence of cystidia or paraphyses, often give them the appearance of being scattered throughout the cavity, especially where the razor tangles the long, thread-like pedicels. The basidium is usually little more than the slightly enlarged end of a hypha and frequently much smaller than one of the spores produced by it. In the development of the sporophore cavities seem to be formed in the outer sterile layer of the gleba when the hyphae cease to elongate and produce basidia at the ends of the hyphae, while the surrounding hyphae elongate rapidly, separating the basidia. A gel, which is either secreted or formed by the disintegration of many of the hyphae in the cavity, fills the cavity and oozes out as a milky liquid when the fructification is cut open. The peridium is thin and usually homogeneous with the gleba. It is variable in thickness, owing to the manner in which the new cavities are formed.

Fischer¹ has recently described development in *Leucogaster floccosus* Hesse. He finds the cavities not lined with a hymenium in the youngest stage studied (3.5×2.5 mm.) but filled with loose tissue of thin-walled hyphae which show marked but wholly irregular swelling and form a loose pseudoparenchyma. The trama consists of parallel, thin-walled, interwoven hyphae. In a later stage ($11 \times 4-5$ mm. in diameter) the cavity has nearly disappeared in a formless gel and the basidia push out into it from the septa.

Fischer evidently studied *L. floccosus* Hesse, although he was not sure that it might not have been *L. fragrans* Mattiolo. A study of the type of the latter shows it to be quite distinct from *L. floccosus*, although it falls into synonymy elsewhere (see p. 403). In the Farlow Herbarium there is a collection of *L. floccosus* from Hesse, dated 1900, which agrees with the description very well.

¹ Fischer, E. Mykologische Beiträge, 25. Jugendstadien des Fruchtkörpers von *Leucogaster*. Naturf. Ges. Bern, Mitt. 1921: 301-307. (20-26). 1922.

It contains 3 large and 2 small fructifications, one of the latter 2×3 mm. in diameter, the other 4×5 mm. They have been preserved in alcohol since 1900 and probably are somewhat shrunken. When collected they were probably about the age of those examined by Fischer. In the smaller specimen the cavities are filled with cells, somewhat irregular on account of mutual pressure, which expand to a spherical form when treated with a dilute solution of potassium hydroxide. A further study shows them to be spores (?) borne acrogenously on short branches of curved or zig-zag hyphae, or sometimes terminally on large hyphae springing from the trama (see pl. 11, fig. 10). When closely packed together they appear in rows, reminding one of the appearance of aecidiospores of the *Uredinales*. As the only material available was no longer viable, whether these organs are true spores must remain in doubt for the present.

Secondary spore forms have not been reported very frequently in *Gasteromycetes*. Fischer¹ has reported cells which he called gemmae in *Sphaerobolus*, and Eidam² and Brefeld³ found that oidia are produced in poorly nourished cultures of the *Nidulariaceae*. In the *Hymenomycetes* most of the literature has been carefully reviewed by Lyman,⁴ Zeller⁵ and Snell,⁶ who show that other spore forms are much more common in these fungi. We⁷ have already noted conidia-like cells produced at the surface of *Arcangeliella caudata* Z & D., although we did not attempt to germinate them. The spores of the present fungus resemble the basidio-

¹ Fischer, E. Zur Entwicklungsgeschichte der Gasteromyceten. Bot. Zeit. 42: 433-443, 449-462, 465-475, 485, 494. pl. 7. 1884.

² Eidam, E. Die Keimung der Sporen und die Entstehung der Fruchtkörper bei den Nidularieen. Beitr. z. Biol. d. Pflanzen 2: 221-249. pl. 10. 1876.

³ Brefeld, O. Botanische Untersuchungen über Schimmelpilze 3: 1-226. pl. 1-11. 1877.

⁴ Lyman, G. R. Culture studies on polymorphism of Hymenomycetes. Boston Soc. Nat. Hist., Proc. 33: 125-209. pl. 18-26. 1907.

⁵ Zeller, S. M. Studies in the physiology of the fungi. II. Lenzites saepiaria Fries, with special reference to enzyme activity. Ann. Mo. Bot. Gard. 3: 439-512. (See pp. 443-444). pl. 8-9. 1916.

⁶ Snell, W. H. Studies of certain fungi of economic importance in the decay of building timbers with special reference to the factors which favor their development and dissemination. U. S. Dept. Agr. Bull. 1053: 1-47. pl. 1-8. 1922.

⁷ Zeller, S. M., and Dodge, C. W. Arcangeliella, Gymnomyces, and Macowanites in North America. Ann. Mo. Bot. Gard. 6: 49-59. 1919.

spores so closely on account of the thick gelatinous sheath that they may be mistaken for the latter. In *Leucophlebs candida* Harkness, one finds that the spore frequently has slipped out of its sheath, reminding one of the germination of the chlamydo-spores of *Fistulina*, reported by de Seynes.¹

In 1899 Harkness described a new genus, *Leucophlebs*, based on 5 species, 3 of which are undoubtedly *Leucogaster* sp. The types of the 2 remaining species are in such a collapsed condition that it is difficult to interpret the structure, but apparently they are the imperfect condition of *Leucogaster*. For the present we would leave this genus among the *Fungi Imperfecti*, analogous to *Ceratomyces* Corda² (*Ptychogaster* Corda), a chlamydo-spore stage of *Polyporus* Micheli ex Fries, in so far as the species have been connected with any perfect stage.

The relationships of *Leucogaster* and *Scleroderma* in connection with the forms originally described as *Phlyctospora* offer an opportunity for further investigation by those having access to young material. There seems to be a series of forms from such species as *Leucogaster luteomaculatus* and *L. floccosus* with their duplex peridia, through such forms as *L. citrinus* to *L. badius*, thence to *Scleroderma* (*Phlyctospora*) *fuscum* and *S.* (*Euscleroderma* ?) *dictyosporum* and *S.* (*Euscleroderma*) *aurantium*, in which there is a gradual thickening of the peridium, a thickening of the gelatinous envelope of the spore with a simultaneous increase in the depth of the warts and reticulations, which finds its most complete expression in the subgenus *Phlyctospora* of *Scleroderma*, and a sudden disappearance of the gelatinous sheath in the subgenus *Euscleroderma*. Observations on the development of *Scleroderma hypogaeum* Zeller by one of us show that the spores of this species are at first surrounded by a thick gelatinous sheath which, upon maturity and drying, disappears. Further, it will be noted that in the above series of forms, all stages are represented, connecting forms with a well-defined and definitely organized hymenium with those in which the basidia are scattered throughout the

¹ de Seynes, J. Recherches pour servir à l'histoire naturelle des végétaux inférieurs. I. Des Fistulines. v+71 pp. 7 pl. Paris, 1874.

² Not Battara. *Ceratomyces* Battara has been used as a segregate of *Boletus* Fries (see North American Flora 9: 136. 1910).

tissue. The series also illustrates a progression from forms which gelatinize throughout to those which finally become dry and dusty at maturity. Until a morphological study can be made, it seems wise to consider all forms with light-colored and hyaline spores enclosed in a definite, globose, gelatinous sheath as species of *Leucogaster*, reserving the dark-colored spore groups for the subgenus *Phlyctospora* of *Scleroderma*.

As in our previous work, we have used as a standard for color descriptions Ridgway, 'Color Standards and Color Nomenclature,' Washington, D. C., 1912. In citing specimens we have given the data accompanying the specimens. Wherever possible the location of the specimens has also been given.

In conclusion we gratefully acknowledge our indebtedness to all who have aided us in this work. We are indebted to the Missouri Botanical Garden for the use of the library and herbarium; to Dr. L. R. Abrams for access to the Dudley Herbarium at Leland Stanford Jr. University, and to Prof. J. McMurphy for assistance in the study of Harkness' specimens there; to Dr. E. A. Burt for access to his private herbarium and for helpful suggestions; to the late W. G. Farlow for access to the collections from Hesse in the Cryptogamic Herbarium of Harvard University, and, since Dr. Farlow's death, to Dr. R. Thaxter for helpful suggestions and for access to his own collections as well as those of the Farlow Herbarium; to Dr. H. D. House for the privilege of studying the type of *Hymenogaster anomalus* Peck from the New York State Museum; to Mr. C. G. Lloyd for access to specimens in the Lloyd Museum; to Mr. H. E. Parks for assistance in collecting fresh material; and to Dr. W. A. Setchell and to Dr. N. L. Gardner for access to the University of California Herbarium.

KEY TO THE SPECIES OF LEUCOGASTER AND LEUCOPHLEBS

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| 1. Peridium duplex, thin, 60-80 μ thick, white spotted with yellow, becoming reddish on drying, basidia linear-oblong..... | |
| | <i>Leucogaster luteomaculatus</i> (p. 394) |
| 1. Peridium simplex, although sometimes with flocculent patches, then much thicker..... | 2 |
| 2. Spores over 16 μ in diameter..... | <i>L. nudus</i> (p. 404) |
| 2. Spores under 16 μ in diameter..... | 3 |
| 3. Peridium of large hyphae (more than 4 μ in diameter)..... | 4 |
| 3. Peridium of slender hyphae..... | 6 |

4. Septa of long hyphae, peridium very thick.....*L. liosporus* (p. 402)
 4. Septa of pseudoparenchyma, peridium 140-220 μ thick..... 5
 5. Spores reticulate.....*L. Tozziana* (p. 403)
 5. Spores aculeate.....*L. Bucholtzii* (p. 404)
 6. Peridium thin (under 180 μ thick)..... 7
 6. Peridium thick (over 200 μ thick)..... 12
 7. Septa thick, 100-150 μ thick, gleba becoming bay or darker..*L. floccosus* (p. 402)
 7. Septa medium, 75-100 μ thick, gleba white..... 8
 7. Septa thin, 20-50 μ thick..... 9
 8. Cavities empty, subhymenial layer compact.....*L. odoratus* (p. 396)
 8. Cavities filled, subhymenial layer loosely woven..*L. foveolatus* (p. 397)
 9. Peridium 15-20 μ thick, surface studded with shallow depressions, white
 *Leucophlebs candida* (p. 407)
 9. Peridium 120-180 μ thick..... 10
 9. Peridium 15-60 μ thick, pseudoparenchymatous, red.....
 *Leucogaster rubescens* (p. 395)
 10. Peridium containing pigmented bodies, citron-yellow..*L. citrinus* (p. 398)
 10. Peridium uniform..... 11
 11. Septa of 3 indefinite layers, basidia long-pedicelled, paraphyses none,
 giving the hymenium an arachnoid appearance, sterigmata short
 *L. araneosus* (p. 399)
 11. Septa thinner, homogeneous, spores 13 μ in diameter, "sterigmata" long
 *Leucophlebs magnata* (p. 406)
 12. Septa thin, 60-120 μ thick, basidia clavate, 22 \times 8 μ , spores 11-13 μ in
 diameter, sterigmata short.....*Leucogaster anomalus* (p. 399)
 12. Septa thick, 150-200 μ thick, basidia pyriform..... 13
 13. Basidia 20-24 \times 12 μ , spores 12-16 μ in diameter, sterigmata short.....
 *L. badius* (p. 400)
 13. Basidia 7-8 \times 5-6 μ , pedicellate, spores 8-10 μ in diameter, sterigmata long
 *L. fulvimaculosus* (p. 401)

1. *Leucogaster luteomaculatus* Zeller & Dodge, sp. nov.

Fructificationes globosae, 2.5 \times 1 cm. metientes, siccatae 1.5 \times 0.8 cm., recentes calceae, cum maculis sordide luteis (Thaxteri memoranda), siccatae "ox-blood red" vel "garnet-brown" (Ridgway), superficiei inaequali, nitenti; funiculi anastomosantes, hinc indeque liberi, nigri, nitentes; peridium 60-80 μ crassitudine, duplex, strato extero facile ab intero separante pannis relictis, 20-30 μ crassitudine, hyphis crassis, septatis, olivaceis-brunneis sub lente, contexto, strato intero 40-50 μ crassitudine, hyphis tenuibus, badiis, granulatis, dense contexto; gleba lactea recens (Thaxtero teste), siccata "cinnamon" vel "clay-color" (Ridgway); locelli globosi vel angulosi, impleti; septa tenuia, 50-60 μ crassitudine, hyalina, hyphis parallelis, crassis, tenuibus cum parietibus, hyalinis contexta, scissilia; basidia hyalina, 7 \times 12 μ , anguste oblonga, bispora; sterigmata 2-4 μ longitudine; sporae dilute olivaceae sub lente, globosae, minute verrucosae in vaginis gelatinosis inclusae, 7-9 μ .

Habitat sub foliis in fagetis, Carolina boreali. Aestate.

Type: in Thaxter Herb.

Fructificationes globose, 2.5 \times 1 cm., drying 1.5 \times 0.8 cm., chalk-white with yellow flecks (Thaxter's field notes), becoming

ox-blood red to garnet-brown on drying, surface uneven, shining; fibrils anastomosing, free in places, black, shining; peridium 60–80 μ thick, duplex, outer layer readily separating from the inner, leaving patches 20–30 μ thick, of large, septate, olive-brown hyphae; inner layer 40–50 μ thick, of slender, reddish brown, granular, closely woven hyphae; gleba milk-white when fresh, drying cinnamon or clay-color; cavities globose to polyhedral, filled; septa thin, 50–60 μ , hyaline, of large, parallel, thin-walled, hyaline hyphae, scissile; basidia hyaline, $7 \times 12 \mu$, narrowly oblong, 2-spored; sterigmata 2–4 μ long; spores light olivaceous under the microscope, globose, minutely verrucose with a gelatinous sheath, 7–9 μ in diameter.

Under leaf mould in beech forests. Europe and North America. Summer.

The duplex character of the peridium, the color both when fresh and upon drying, as well as the very thin peridium, should serve to distinguish this species from other members of the genus.

Specimens examined:

Exsiccati: D. Saccardo, Mycoth. Ital., 1424.

Switzerland: *E. Butignot* (in Lloyd Mus. 025).

Italy: Firenze, Vallombrosa, *A. Fiori* in D. Saccardo, Mycoth. Ital., 1424 (in Farlow Herb. at Harvard Univ.).

North Carolina: Cranberry, *R. Thaxter*, 3, type (in Thaxter Herb. and in Farlow Herb. at Harvard Univ.).

California: Santa Clara County, *H. E. Parks*, 908 (immature) and 915 (in Univ. Cal. Herb., and in Dodge Herb. 2104).

2. *Leucogaster rubescens* Zeller & Dodge, sp. nov.

Fructificationes subglobosae vel irregulares, primum albiae vel carneaе, deinde "brick-red" vel "Hessian brown" (Ridgway), superficie levi vel inaequali, viscida; funiculi concolores saturatioresve, innati-appressi; peridium 15–35 μ crassitudine (aliquando 40–60 μ) pseudoparenchymate gelatinoso, fragile, "orange rufous" (Ridgway) siccatum; gleba siccata cremea vel "ivory-yellow" (Ridgway) secata; locelli circa 0.5 mm., globosi vel angulosi; septa hyalina, 35–55 μ crassitudine, hyphis tenuibus scissilescentibus; basidia hyalina, pyriformia, 15–25 \times 8–14 μ , pedicello 50–125 μ longitudine, tetraspora, sterigmatibus 2–4 μ longitudine; sporaе sphaericae oblongaеve, echino-reticulatae, subhyalinae, 11–15 μ (cum vagina gelatinosa, 6–10 μ sine vagina).

Sub foliis in aceretis. Oregon. Veri.

Type: in Zeller Herb., Dodge Herb., and Oregon Agr. Coll. Herb.

Fructifications subglobose to irregular, at first whitish to flesh-pink, becoming brick-red to Hessian brown, surface smooth, uneven, viscid when moist; fibrils concolorous or darker, innately appressed; peridium usually 15–35 μ thick (sometimes 40–60 μ), composed of gelatinized pseudoparenchyma, drying brittle and orange rufous, lined with the fine, hyaline hyphae of the outer layer of the gleba (showing white in cross-section); gleba drying cream-color or ivory-yellow when cut after drying; cavities averaging about 2 to the mm., globose to polyhedral, lined with a clear gelatinous mucus, embedding the long-pedicelled basidia and spores; septa hyaline, 35–55 μ thick, of thin-walled hyphae, becoming scissile; basidia not in a definite hymenium, hyaline, pyriform, 15–25 \times 8–14 μ , on pedicels 50–125 μ long, 4-spored; sterigmata 2–4 μ long; spores spherical to oblong, echino-reticulate, almost hyaline, 11–15 μ (including gelatinous sheath), spore alone 6–10 μ .

In leaf mould under maples. Oregon. May.

The thin pseudoparenchymatous peridium, which is vivid red, and the echino-reticulate spores separate this species from others of the genus.

Specimens examined:

Oregon: Corvallis, *L. M. Boozer*, type (in Oregon Agr. Coll. Herb. 3706, in Zeller Herb. 2322, and in Dodge Herb. 2072).

3. *Leucogaster odoratus* (Harkness) Zeller & Dodge, comb. nov.
Leucophleps odorata Harkness, Cal. Acad. Sci. Proc. Bot. III. 1: 258. 1899; Saccardo & Sydow in Sacc. Syll. Fung. 16: 252. 1902.

Illustrations: Harkness, Cal. Acad. Sci. Proc. Bot. III. 1: pl. 43. f. 9; Rev. Myc. 22: pl. 204. f. 12.

Type: in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications oblong or irregularly lobed, large, 3–4 cm. in diameter, light orange, fading in alcohol; fibrils and columella wanting; peridium thin, about 100 μ thick, of compactly woven, gelatinized hyphae, homogeneous with the septa; gleba white, cavities round, empty; septa about 75 μ thick, of 3 layers, the middle layer of parallel, gelatinized hyphae, subhymenial layers of closely interwoven hyphae, hymenium of long-pedicelled

basidia, $20 \times 5 \mu$; no paraphyses; sterigmata short; spores hyaline, reticulate in gelatinous sheath, globose to slightly ellipsoidal, $8-11 \mu$ in diameter.

California. June to July.

The freshly cut gleba exudes a milky juice, probably a dense suspension of spores, as no definite latex organs were seen. This, with the large, spherical empty cavities and its color, makes it quite easy to recognize in the field.

Specimens examined:

California: Shasta County, Castle Crag, *H. W. Harkness, 251*, type (in Dudley Herb. at Leland Stanford Jr. Univ.); Santa Clara County, Saratoga, Boys' Outing Farm, *H. E. Parks & C. W. Dodge* (in Dodge Herb. 1529).

4. *Leucogaster foveolatus* (Harkness) Zeller & Dodge, comb. nov.

Leucophleps foveolata Harkness, Cal. Acad. Sci. Proc. Bot. III. 1: 258. 1899; Saccardo & Sydow in Sacc. Syll. Fung. 16: 252. 1902.

Type: in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications subglobose, 1 cm. in diameter, white or faintly citron color; fibrils few, small, white; columella wanting; peridium thin, $75-100 \mu$ thick, of very slender, compactly woven hyphae, homogeneous with the septa which show through as reticulations or pits on the surface; gleba white, cavities rounded, filled with hyphae; septa $75-100 \mu$ thick, of 3 layers, the middle layer of compactly woven, gelatinized hyphae, subhymenial layer of larger, more loosely woven hyphae; basidia clavate, $12 \times 7 \mu$, disappearing, leaving spores sticking to walls of the cavity hyphae; sterigmata long; spores hyaline, guttulate, reticulate in a gelatinous sheath, sometimes slipping out at maturity, globose to slightly ellipsoidal, $7-12 \mu$.

Moist earth. British Columbia to California. July to September.

Leucophleps gibbosum Harkness, herb. nom., is a lighter form, irregular in shape but structurally similar (Harkness 124, without locality data in Dudley Herb. at Leland Stanford Jr. Univ.).

Specimens examined:

British Columbia: south of Beavermouth along Quartz Creek Trail, *C. W. Dodge, 1545* (in Dodge Herb.).

California: Marin County, Mill Valley, *H. W. Harkness, 209*, type (in Dudley Herb. at Leland Stanford Jr. Univ.).

5. *Leucogaster citrinus* (Harkness) Zeller & Dodge, comb. nov. *Leucophleps citrina* Harkness, Cal. Acad. Sci. Proc. Bot. III 1: 259. 1899; Saccardo & Sydow in Sacc. Syll. Fung. 16: 252. 1902.

Illustrations: Harkness, Cal. Acad. Sci. Proc. Bot. III. 1: pl. 43, f. 8; Rev. Myc. 22: pl. 204, f. 10-11.

Type: in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications solitary, subglobose, 2 cm. in diameter, "citron color, imparting a reddish color to alcohol when immersed" (Harkness), becoming dirty vinaceous buff when dry; peridium 140-170 μ thick, composed of uniform, small, closely woven hyphae, appearing light chalcedony-yellow, homogeneous except for included sand and globose to irregular pigmented bodies, 12-20 μ in diameter, appearing granular, tawny to buckthorn-brown; gleba ivory-yellow when dry; cavities large, globose, empty; septa 20-30 μ thick between hymenial layers, composed of very slender, closely woven, hyaline hyphae; basidia narrowly clavate, 16-25 \times 2-4 μ , hyaline, filled with oil globules, 2-4-spored; sterigmata 5-7 μ long, slender; spores brown in mass, sybhyaline under the microscope, pitted or minutely verrucose, 7-11 μ in diameter, surrounded by a gelatinous sheath approximately 1-2 μ thick.

Under manzanita and laurel. California. April.

Cremogaster levisporus Mattiolo agrees with this species in all respects except that it is slightly younger material and the spore is scarcely pitted yet.

Specimens examined:

California: Marin County, Mt. Tamalpais, *H. W. Harkness, 168*, type (in Dudley Herb. at Leland Stanford Jr. Univ. and in Farlow Herb. at Harvard Univ.); Santa Clara County, Saratoga, Boys' Outing Farm, *Dale Parks* (in Univ. Cal. Herb., under H. E. Parks, 816); Call of the Wild, *H. E. Parks, 37b* (in Univ. Cal. Herb.); San Antonio Mts., *I. M. Johnston*, type of *Cremogaster levisporus* Mattiolo (in Lloyd Mus.).

6. *Leucogaster araneosus* Zeller & Dodge, sp. nov.

Fructificationes globosae, 0.6 cm. in diametro metientes, servatae "snuff-brown" vel "bister" (Ridgway); funiculi magni sed non prominentes, pauci, semi-innati, subramosi; peridium 130–180 μ crassitudine, simplex, hyphis dilute brunneis tenuissimis dense contextum; gleba alba, fulvis cum maculis; locelli subglobosi, impleti; septa tenua, 40–50 μ crassitudine inter hymenia, compacta, stratis tribus composita, strato medio dilute brunneo, stratis caeteris hyalinis; stratum hymeniale quasi araneosum (unde nomen); paraphyses nulli; basidia hyalina, granulato-guttulata, 8–10 \times 6–8 μ , piriformia, in pedicellis ad 300 μ longitudine imposita, tetraspora; spora hyalinae, globosae, alveolato-reticulatae, angulis alveolarum prominentibus velut spinis obtusis, in vaginis gelatinosis inclusae, 8–11 μ in diametro.

Habitat in Carolina boreali. Aestate.

Type: in Thaxter Herb.

Fructifications globose, 0.6 cm. in diameter in preserved material, snuff-brown to bister; fibrils large but not prominent, few, half-immersed, somewhat branched; peridium 130–180 μ thick, simplex, of closely woven, very slender, light brown hyphae; gleba white with tawny spots; cavities subglobose, filled; septa thin, 40–50 μ thick between hymenia, compact, of 3 layers, the middle layer being light brown, the other 2 layers hyaline; hymenial layer arachnoid; paraphyses none; basidia hyaline, granulate-guttulate, 8–10 \times 6–8 μ , pyriform, on pedicels up to 300 μ long, 4-spored; spores hyaline, globose, alveolate-reticulate, angles of alveoli projecting as blunt spines, in a gelatinous sheath, 8–11 μ in diameter.

North Carolina. Summer.

Specimens examined:

North Carolina: Cranberry, *R. Thaxter*, 96 (in Thaxter Herb. and Farlow Herb. at Harvard Univ.).

7. *Leucogaster anomalus* (Peck) Zeller & Dodge, comb. nov.

Hymenogaster anomalus Peck, N. Y. State Mus. Bull. 116: 31–32. 1907 (also cited as N. Y. State Ed. Dept. Bull. 404: 31–32. 1907, and as Rept. State Botanist [N. Y.] 1906: 31–32. 1907); Saccardo & Trotter in Sacc. Syll. Fung. 21: 496. 1912.

Type: in Coll. N. Y. State and in U. S. Nat. Herb.

Fructifications globose to irregular, 1–2.5 cm. in diameter, cinnamon-buff, clay-color, and tawny olive to Mikado brown above, Hay's russet and liver-brown below, "glabrous, slightly lacunose, often with a root-like strand of mycelium at the base,

. . . sterile base obsolete or nearly so, odor slight, not disagreeable," (Peck); peridium 240–520 μ thick, grenadine to English red near the surface to hyaline within, composed of very slender interwoven hyphae; gleba amber-brown to Sudan brown, sometimes lighter; cavities large, mostly more than 1 mm. in diameter, subglobose to irregular, empty; septa 60–120 μ , composed of very closely woven, hyaline hyphae, not scissile; cystidia none, paraphyses clavate, granularly guttulate; basidia clavate, 22–24 \times 8 μ , hyaline, 4-spored; spores almost sessile, dilute cream-colored to hyaline, globose, 11–13 μ in diameter, uninucleate, surface pitted, giving the appearance of hexagonal reticulations, surrounded by a hyaline, gelatinous sheath.

Hypogaeous, in woods. District of Columbia. August to September.

Specimens examined:

District of Columbia: Washington, Rock Creek Park, *T. E. Wilcox*, type (in Coll. N. Y. State and U. S. Nat. Herb.).

8. *Leucogaster badius* Mattiolo, R. Accad. Sci. Torino, Mem. II. 53: 356. 1903; Saccardo & Saccardo in Sacc. Syll. Fung. 17: 240. 1905.

Illustrations: Mattiolo, R. Accad. Sci. Torino, Mem. II. 53: *pl. unnumbered, f. 1–3.*

Type: probably in Mattiolo Herb. and in Collezione Beccari, Herb. Cesatiano at the R. Ist. Bot. di Roma, but not seen.

Fructifications subglobose, 1 cm. in diameter, raw sienna to raw umber, surface pitted, glabrous; stipe very slender, from a very slight, inconspicuous, sterile base; peridium 200–340 μ thick, ochraceous-buff, stupose, composed of very slender hyphae; gleba raw umber; cavities polygonal, filled with spores in a gelatinous mass due to deliquescence, 0.7–1.0 mm. in diameter; septa 160–200 μ thick, composed of compactly woven, gelatinous, cream-colored hyphae; cystidia none; basidia hyaline, pyriform, 20–24 \times 12 μ , 4-spored, guttulate; spores almost sessile, subglobose, 12–16 μ in diameter, cream-colored, surface pitted, giving the appearance of hexagonal reticulations, surrounded by a hyaline, gelatinous sheath.

On the ground, under leaves. Italy and New York, July and August.

Specimens examined:

New York: East Galway, *E. A. Burt* (in Burt Herb.).

9. *Leucogaster fulvimaculosus* Zeller & Dodge, sp. nov.

Fructificationes globosae, 2.0–2.5 cm. in diametro metientes, siccatae “cinnamon buff,” “tawny” (Ridgway) maculatae; funiculi non prominentes, pauci, concolori; peridium 375–425 μ crassitudine, simplex, compactum, hyphis tenuibus dense contextum; gleba “warm buff” (Ridgway) vel dilutior; locelli globosi vel angulosi, semi-impleti; septa 150–180 μ crassitudine, hyalina, hyphis tenuibus dense contexta, non scissilia; basidia hyalina, 7–8 \times 5–6 μ , piriformia, in pedicellis 90 μ longitudine imposita, trispora; sterigmata conica, 2 μ longitudine; sporae hyalinae servatae, brunneae siccatae, sphaericae vel ovoideae, verrucosae vel reticulatae, in vaginis gelatinosis inclusae, 8–10 μ diametro.

Habitat in silvis udosis. Civ. Noveboracensi. Aestate.

Fructifications globose, 2.0–2.5 cm. in diameter, drying cinnamon-buff, spotted with tawny; fibrils not prominent, few, concolorous; peridium 375–425 μ thick, simplex, compact, of closely woven, slender hyphae; gleba warm buff or lighter; cavities globose or polyhedral, half filled; septa 150–180 μ thick, hyaline, of closely woven slender hyphae, not scissile; basidia hyaline, 7–8 \times 5–6 μ , pyriform, on pedicels about 90 μ long, 3-spored; sterigmata conical, 2 μ long; spores hyaline in preserved material, brown in dry material, spherical to ovoid, verrucose to reticulate, leaving a pore where detached from the sterigma, inclosed in a gelatinous sheath, 8–10 μ in diameter.

Damp woods. New York. Summer.

The peridium of this species appears to be variable in thickness, new cavities seeming to form in the inner layer as the fructification increases in size, with the hyphae next the basidia-bearing hyphae gelatinizing and finally disappearing. A study of young material is very desirable for further interpreting this phenomenon.

Specimens examined:

New York: Long Island, Cold Spring Harbor, *A. F. Blakeslee*, type (in Farlow Herb. at Harvard Univ.).

EXTRA-LIMITAL SPECIES

The following species of *Leucogaster* have not yet been noted from North America, but are included in order to assist in referring material to them in case they should be found later, as individual species in this family have wide ranges.

1. *Leucogaster liosporus* Hesse, Jahrb. f. wiss. Bot. 13: 190. 1882; Hypog. Deutschl. 1: 70-71. 1891; Saccardo, Syll. Fung. 9: 281. 1891.—*Octaviania silesiaca* Becker, Die Natur 35: 356. 1886, fide Schroeter in Cohn, Kryptog.-Fl. von Schlesien 3¹: 710-711. 1889.—*Octaviania* ? *Gautieria* ? *pityophila* Becker, Die Natur 35: 356. 1886, fide Schroeter in Cohn, Kryptog.-Fl. von Schlesien 3¹: 710-711. 1889.

Illustrations: Hesse, Jahrb. f. wiss. Bot. 13: f. 1-6; Hypog. Deutschl. 1: pl. 3. f. 14-15.

Type: location unknown to us.

Fructifications very irregular, variable in size, citron-yellow, odor none; fibrils free, branched, becoming 3 mm. thick at maturity; peridium thick, 1.5-2.5 mm. thick when fresh (teste Hesse), 100-140 μ when preserved in alcohol, smooth, composed of thick yellowish hyphae; gleba white; cavities polygonal, larger at the center than at the peridium, filled at maturity; septa composed of long, thin hyphae; basidia broadly clavate to subglobose; sterigmata very short; spores 12 μ in diameter, rough, surrounded by a gelatinous sheath.

In birch woods. Central Europe.

A specimen in the von Hoehnel Herbarium, 2605a, agrees with the description of this species, except that the cavities are elongated radially from the base, as Hesse has figured in one case for *L. floccosus*, and are not filled at maturity. The *Leucophleps* stage of this specimen shows spores borne terminally on short branches of the cavity hyphae. These spores resemble basidiospores but have smoother and thinner walls and small germ pores. The sporiferous branch of a cavity hypha usually remains attached to the spore.

Specimens examined:

Austria: Reinberg bei Altenmarkt, Coronathal, *Fr. von Hoehnel, 2605a* (in von Hoehnel Herb. at Farlow Herb., Harvard Univ.).

2. *Leucogaster floccosus* Hesse, Bot. Centralbl. 40: 1-4, 33-36. 1889; Hypog. Deutschl. 1: 68-70. 1891; Saccardo, Syll. Fung. 9: 281. 1891.

Illustrations: Hesse, Bot. Centralbl. 40: pl. 1, 2. f. 1-9; Hypog.

Deutschl. 1: pl. 3, f. 8-13; pl. 5, f. 8; pl. 7, f. 1-3; pl. 8, f. 1-20; pl. 9, f. 1-13.

Type: location unknown to us.

Fructifications irregular, variable in size, light yellow (Hesse), bay to auburn in alcohol; fibrils loose, round, black or nearly so; peridium with thick, flocculent concolorous patches, 120-150 μ thick, composed of small hyphae, outer ones colored to a depth of 10 μ , inner ones gelatinizing; gleba slightly darker, waxy in preserved specimens; septa hyaline, 100-150 μ , composed of large, closely woven hyphae; basidia 2-3-spored, $7 \times 12 \mu$; spores echinulate, 4 μ in diameter, surrounded with a gelatinous sheath, making a total diameter of 7-10 μ .

Hypogaeous in birch and oak woods, England and Germany. August and September.

Specimens examined:

Exsiccati: Rabenhorst, Fung. Eur. 38.

England: Batheaston, C. E. Broome (in Rabenhorst, Fung. Eur., 38, under the name *Hymenogaster citrinus* Vitt., copy in Farlow Herb. at Harvard Univ.).

Germany: Hesse-Nassau, Kirchain, R. Hesse, 1902 (in Farlow Herb. at Harvard Univ.).

3. *Leucogaster Tozziana* (Cavara & Saccardo) Mattiolo in litt., comb. nov.

Endogone Tozziana Cavara & Saccardo, Nuov. Giorn. Bot. Ital. II. 7: 296. Jy. 1900; Saccardo & Sydow in Sacc. Syll. Fung. 16: 816-817. 1902.—*Leucogaster* sp. Baccarini, Nuov. Giorn. Bot. Ital. II. 10: 80. 1903; Thaxter, Am. Acad. Arts & Sci., Proc. 57: 326. 1922.—*Leucogaster fragrans* Mattiolo, Malpighia 14: 267. Dec. 1900; Saccardo & Sydow in Sacc. Syll. Fung. 16: 249. 1902.

Type: in Cavara Herb. and portion in Mattiolo Herb.

Fructifications irregular or gibbous, sulcate, 1-2.5 cm. in diameter, sulphur-colored, becoming vinaceous buff or darker in alcohol; odor of *Tuber Borchii* (Mattiolo); fibrils adherent to almost free, concolorous, sometimes surrounding the fructification, sometimes mostly on the under side; peridium 140-220 μ thick, simplex, composed of large, parallel, thin-walled hyphae, 4-7 μ

in diameter, forming a pseudoparenchyma; gleba white, becoming Sayal brown in alcohol, cavities variable in size, polygonal; septa 40–60 μ thick, composed of pseudoparenchyma much as in the peridium; basidia clavate, $20 \times 7 \mu$, disappearing early; sterigmata 2 μ long; spores globose, 12 μ in diameter, reticulate, surrounded by a gelatinous sheath.

In pine and fir forests. Italy.

Specimens examined:

Italy: Vallombrosa, *O. Mattiolo*, Nov. 23, 1899, cotype of *Leucogaster fragrans* (in Mattiolo Herb. and portion in Thaxter Herb.); *O. Mattiolo*, 1910 and undated specimen (in Lloyd Mus. unnumbered and 064); Nocciuolo sopra Vallombrosa, *F. Cavara*, type (preparation from Mattiolo in Thaxter Herb.).

4. *Leucogaster Bucholtzii* Mattiolo, *Malpighia* 14: 267–268. 1900; Saccardo & Sydow in *Sacc. Syll. Fung.* 16: 249. 1902.

Type: location unknown to us.

Characters of *L. Tozziana* (Cav. & Sacc.) Matt. with aculeate, instead of reticulate, spores.

In fir forests. Vallombrosa, Italy. Summer.

There seems to be so little in the original description to separate this species from *L. Tozziana* that we are inclined to regard it as a variety of this species, but reserve our decision until authentic material has been studied. It is possible that a careful comparison of collections referable here would show all the variations between fructifications with reticulate spores and those with aculeate ones.

5. *Leucogaster nudus* (Hazslinszky) Hollós, *Mus. Nat. Hungarici*, Ann. 6: 319. 1908; Magyarország Földalatti Gombai 98, 208. 1911 (excl. syn.).—*Hydnangium nudum* Hazslinszky, K. K. Zool.-bot. Ges. in Wien, Verhandl. 25: 64–65. 1875; Magyar Tudományos Akad. Termesztud. Közl. 13: (9). 1875 (often cited as Magyarhon hasgombai, 9. 1876); *Hedwigia* 16: 44. 1877; Saccardo, *Syll. Fung.* 11: 172. 1895.

Illustrations: Hazslinszky, K. K. Zool.-bot. Ges. in Wien, Verhandl. 25: pl. 3; Hollós, Magyarország Földalatti Gombai pl. 3, f. 34, 35, pl. 5, f. 33.

Type: in Magyar Nemzeti Museum in Budapest (fide A. de Degen in litt.) not seen.

Fructifications globose to irregular by the coalescence of several fructifications, smooth with surface foveolate, 1–5 cm. in diameter, yellowish white, becoming fuscous; peridium thin, at first white and glistening, then ochroleucous, gelatinous to waxy; cavities subglobose to polyhedral, larger in the center of the fructification, filled at first, becoming empty; basidia pyriform, 4-spored, not in a distinct layer; spores sessile, spherical, ochraceous, blunt echinulate with thick yellow reticulations, gelatinous sheath smooth, 16–18 μ in diameter.

Under *Picea*, Bartfeld, Czechoslovakia. August.

From a study of Hazslinszky's material, Hollós thought *L. liosporus* was a synonym of this species. He did not see any of Hesse's material of *L. liosporus*, and we prefer to recognize both names until we have seen authentic material of both. The above description is a condensation of a translation from Hollós and should be used with caution, as Hollós seems to have conflated a description based on Hazslinszky's material with Hesse's description of *L. liosporus*. From the above description the present species seems more closely related to *Leucophlebs candida* Harkn.

LEUCOPHLEBS¹

Leucophlebs Harkness, Cal. Acad. Sci. Proc. Bot. III. 1: 257–259. 1899; Fischer in Engler & Prantl, Die Nat. Pflanzenfam. I. 1^{**}: 557. 1900; Saccardo & Sydow in Sacc. Syll. Fung. 16: 251–252. 1902.—*Leucophlebs* Roumeguère, Rev. Myc. 22: 83. 1900.

The type species of the genus is considered to be *Leucophlebs magnata* Harkness. Harkness did not definitely designate the type species but he probably had in mind *L. magnata*, for that species is followed by "gen. nov. et sp. nov.," while the other species which he included in the genus are followed by "sp. nov." only. The international rules do not cover this case, but canons 14 and 15 of the "American" code² and article 7g of the recom-

¹ Spelling corrected by Roumeguère, Rev. Myc. 22: 83. 1900, in accordance with international rules.

² Nomenclature Commission of the Botanical Club of the American Association for the Advancement of Science. American code of botanical nomenclature. Torr. Bot. Club Bull. 34: 167–178. 1907 (see p. 172–173).

mendations of the Committee on Nomenclature of the Botanical Society of America¹ both point to the adoption of this species as the type of this genus.

Fructifications globose to irregular, hypogaeous; columella, stipe, or sterile base none; peridium usually thin and fragile, simplex, white; gleba white or slightly yellowish; cavities filled with hyphae bearing spores terminally on short branches; septa thin, homogeneous; spores echinate or reticulate at maturity, surrounded by a gelatinous sheath, globose, resembling those of *Leucogaster*.

From our study of the young stages of *Leucogaster floccosus* Hesse (p. 390), it seems probable that eventually *Leucophlebs* will be recognized as the chlamydosporic condition of *Leucogaster*, or retained as a hypogaeous genus of the *Fungi Imperfecti*.

1. *Leucophlebs magnata* Harkness, Cal. Acad. Sci. Proc. Bot. III. 1: 257-258. 1899; Roumeguère, Rev. Myc. 22: 83. 1900; Saccardo & Sydow in Sacc. Syll. Fung. 16: 252. 1902.

Illustrations: Harkness, Cal. Acad. Sci. Proc. Bot. III. 1: pl. 42. f. 7a-7c; Rev. Myc. 22: pl. 204. f. 6-8.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructification 3 cm. in diameter, subglobose or elongate, white, smooth; peridium 120-150 μ thick, composed of fine, thick-walled, closely woven hyphae, white; gleba white, the freshly cut surface showing a blue tint which soon vanishes; cavities decreasing in size toward the surface, full of cobwebby hyphae like a capillitium; septa thin, homogeneous, 60-80 μ thick, composed of closely woven, hyaline hyphae; spores borne terminally on long slender branches of the cavity hyphae, hyaline, spherical, echinate, enclosed in a gelatinous sheath, 13 μ in diameter.

Under *Acer* and *Quercus*. Oregon to California. April and May.

In Harkness, 100b, crystalline matter is found in the peridium and in Harkness, 154b, the spores become quite thick-walled. The spines on the spores are arranged in rows, giving the appearance shown by Harkness (*l.c.*, f. 7c) when not quite in focus.

Specimens examined:

¹Committee on Nomenclature of the Botanical Society of America. Report. Bot. Soc. Am. Publ. 73: 70-71. 1919 (see p. 71).

Oregon: Corvallis, *L. M. Boozer* (in Oregon Agr. Coll. Herb. 4831, 4832, and Zeller Herb. 2323, 2324, and in Dodge Herb. 2073, 2074).

California: *H. W. Harkness*, 100b, 154b; Napa County, Calistoga, *H. W. Harkness*, 154, cotype (all in Dudley Herb. at Leland Stanford Jr. Univ.).

2. *Leucophlebs candida* Harkness, Cal. Acad. Sci. Proc. Bot. III. 1: 258. 1899; Roumeguère, Rev. Myc. 22: 83. 1900; Saccardo & Sydow in Sacc. Syll. Fung. 16: 252. 1902.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications 2 cm. in diameter, irregular, white, surface studded with shallow depressions; peridium 15–20 μ thick, homogeneous with the septa; gleba white, becoming yellowish in alcohol; cavities filled with branched hyphae which bear spores terminally on the branches; septa thin; spores hyaline, spherical, reticulate at maturity, enclosed in a gelatinous sheath, 8 μ in diameter.

California. June.

The cotype of this species is so badly parasitized that its structure is very difficult to make out.

Specimens examined:

California: Marin County, Mill Valley, *H. W. Harkness*, 207, cotype (in Dudley Herb. at Leland Stanford Jr. Univ.).

3. *Hydnangium liospermum* Tulasne, Fung. Hypog. 76. 1851; DeToni in Saccardo, Syll. Fung. 7: 176. 1888; Hesse, Hypog. Deutschl. 1: 84. 1891.—*Octaviania liosperma* Lloyd, Myc. Notes 67: 1141. 1923.

Illustrations: Tulasne, Fung. Hypog. pl. 21. f. 1.

Type: location unknown to us.

Fructification small (size of a pea), firm, globose, white, with a slight, sterile base, here and there enveloped in a white floccose mycelium separating in places; peridium thick, homogeneous, not separable, white, continuous with the septa; gleba firm, light ochraceous to apricot color; cavities unequal in size, narrow-oblong, radiating from the center to the periphery; septa mucous-cartilaginous, gray, hyaline by transmitted light, variable in

thickness, some arising from the base much thicker than others, homogeneous, of large, closely woven hyphae; spores borne terminally, mostly on 2-celled branches, globose, small, 6.5μ in diameter, smooth, thick-walled.

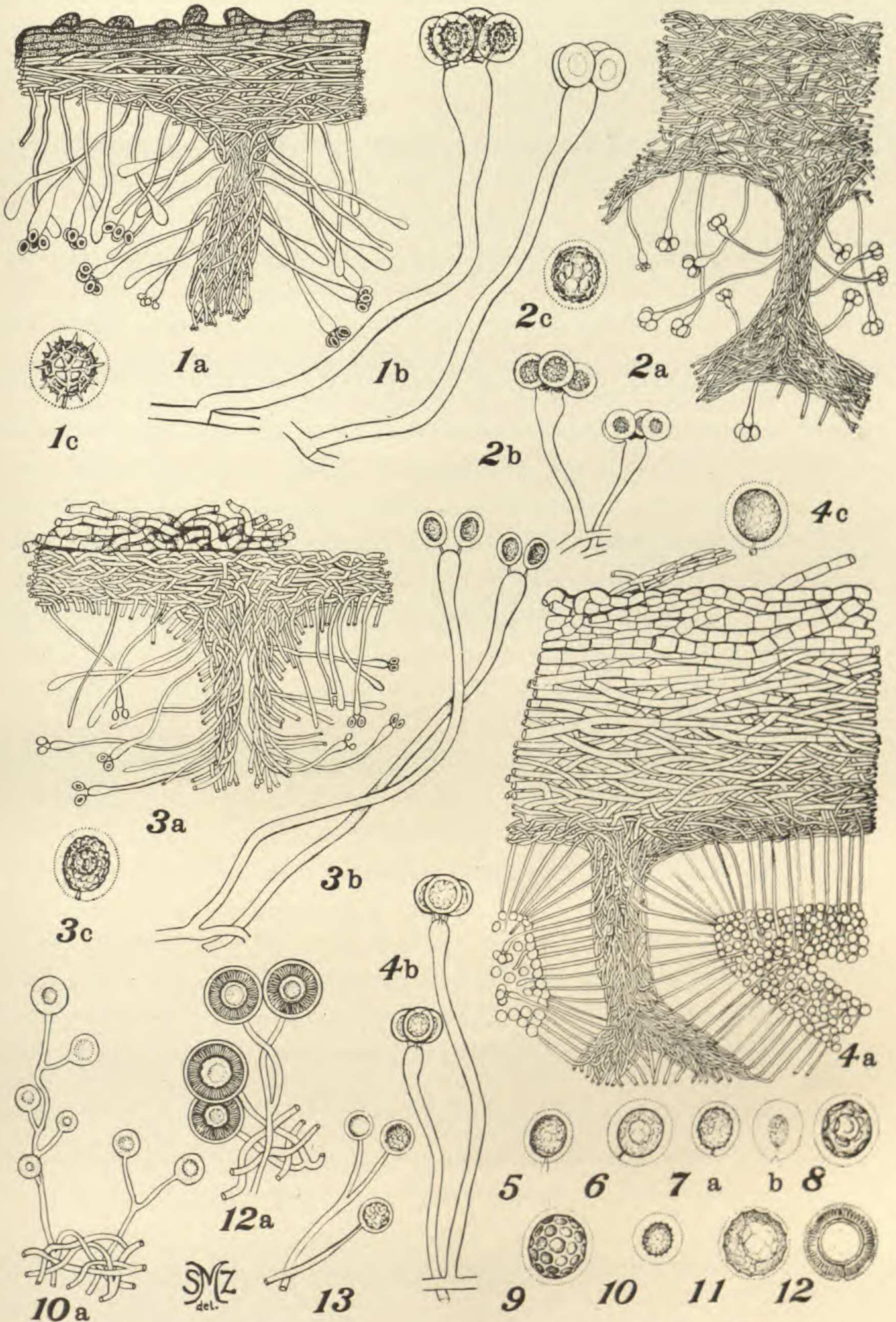
Under fallen leaves in oak woods, almost epigaeous. Not far from Orleans (Parc de Beauvoir near Brivodurum). Autumn.

Hesse referred here a specimen in the Danziger Museum collected by Bail in Kreis Schwetz near Teufelsstein, October, 1878. From the above description it seems quite likely that this species is to be referred to *Leucophlebs*, where the small spores, yellow gleba, radiating elongated cavities, and rudimentary columella should serve to distinguish it from other members of this genus. However, we prefer not to make the transfer until we have the opportunity to study authentic material.

EXPLANATION OF PLATE

PLATE 11

- Fig. 1. *Leucogaster rubescens* Zeller & Dodge.
 a. Section of peridium and septa showing pseudoparenchyma of the peridium, sections of fibrils on the surface, and the 4-spored basidia. Young material, $\times 150$.
 b. Young and mature basidium and spores, $\times 500$.
 c. Basidiospore showing the echino-reticulate character of the surface with gelatinous sheath, $\times 750$.
- Fig. 2. *Leucogaster araneosus* Zeller & Dodge.
 a. Section of fibrous peridium and relation of septa showing the 4-spored basidia. Young material, $\times 150$.
 b. Basidia, $\times 500$.
 c. Basidiospore showing the alveolate-reticulate character of the surface, with blunt spines projecting from the angles of the alveoli and gelatinous sheath, $\times 1000$.
- Fig. 3. *Leucogaster luteomaculatus* Zeller & Dodge.
 a. Section showing the duplex character of the peridium (the outer partly sloughed off), the scissile septum and basidia, $\times 150$.
 b. Basidia, $\times 500$.
 c. Basidiospore showing the verrucose character of the surface with gelatinous sheath, $\times 1000$.
- Fig. 4. *Leucogaster fulvimaculosus* Zeller & Dodge.
 a. Section showing the thick peridium, with portion of fibril on surface, septa, definite layer of basidial stalks embedded in a gelatinous layer within the cavities and the basidiospores lining the cavities, $\times 150$.
 b. Basidia showing the typical 3-spored tips, $\times 500$.
 c. Basidiospore showing the simple reticulate surface with gelatinous sheath, $\times 750$.
- Fig. 5. Basidiospore of *Leucogaster odoratus* (Harkn.) Zeller & Dodge, $\times 750$.
- Fig. 6. Basidiospore of *Leucogaster foveolatus* (Harkn.) Zeller & Dodge, $\times 750$.
- Fig. 7. Basidiospores of *Leucogaster citrinus* (Harkn.) Zeller & Dodge.
 a. Mature spore, $\times 750$.
 b. Young spore, $\times 750$.
- Fig. 8. Basidiospore of *Leucogaster anomalus* (Peck) Zeller & Dodge, showing the pitted surface, $\times 750$.
- Fig. 9. Basidiospore of *Leucogaster badius* Matt. showing the pitted surface, $\times 750$.
- Fig. 10. Basidiospore of *Leucogaster floccosus* Hesse, showing the echinulate-reticulate character of the exospore and thick gelatinous sheath, $\times 750$.
- Fig. 10a. The conidia from young cavities of *Leucogaster floccosus*. This conidial stage cannot be distinguished from *Leucophlebs* Harkness, $\times 500$.
- Fig. 11. Basidiospore of *Leucogaster Tozziana* (Cav. & Sacc.) Matt., $\times 750$.
- Fig. 12. Conidium of *Leucophlebs magnata* Harkn. showing the peculiar markings in median view, $\times 750$.
- Fig. 12a. Shows the conidia and conidiophores of *L. magnata*, $\times 500$.
- Fig. 13. Conidia and conidiophores of *Leucophlebs candida* Harkn., $\times 500$.



ZELLER AND DODGE—LEUCOGASTER AND LEUCOPHLEBS